JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1981, 14, 273-285 NUMBER 3 (FALL 1981)

A COMPANY-BASED LOTTERY TO REDUCE THE PERSONAL DRIVING OF EMPLOYEES

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A company-based lottery was used to reduce the number of nonessential miles employees drove their personal cars each day and thereby save gasoline. Employees were divided into an experimental and a contrast group. The experimental design involved two conditions: (a) a baseline in which no consequences were attached to driving behavior, and (b) a month-long lottery in which the experimentals were rewarded for decreasing their percentage of average miles driven per day relative to their initial baseline average. The experimentals received an ABA order of conditions while the contrast group remained in baseline. The lottery condition consisted of four weekly lotteries and one grand drawing held at the end of the month. During the lottery condition, the experimentals reduced their average daily mileage by 11.6% relative to their initial baseline (7.85 miles per employee per day) while the contrast employees increased their average mileage by 21.2%. Both groups exceeded their initial baseline averages in the return to baseline. The study was almost cost-effective because the experimentals' gas savings ($75) was within $4 of the cost of motivating them to reduce their mileage ($79).

DESCRIPTORS: gasoline conservation, auto-mileage reduction, driving behavior, monetary reinforcement, feedback, lottery, self-recording, contrast groups, company employees

Reinforcement contingencies have been applied to gasoline conservation in an attempt to develop a behavioral approach to the fuel crisis (Foxx & Hake, 1977; Hake & Foxx, 1978). In the first application (Foxx & Hake, 1977), a methodology was developed for studying driving behavior and an average mileage reduction of 20% was achieved by 12 college students over a 1-mo reinforcement period. A second study (Hake & Foxx, 1978) replicated and extended the previous research because nine college students averaged mileage reductions of 22.5% over a 1-mo period. The extensions included a weekly fixed-interval reinforcement schedule contingency to increase short-term control, the measurement of the effects of a leader variable, and the assessment of the effect of self-recording mileage.

These two studies demonstrated the feasibility of using reinforcement contingencies to reduce college students' driving. The purpose of the present study was to attempt to develop a cost-effective and realistic driving reduction program for a business setting. Accordingly, a number of changes were made.

A natural work environment was studied. In the previous research, all subjects were college students. Although Hake and Foxx (1978) included only students who were commuters and who had some essential driving (i.e., between home and school), their average number of miles driven per day had been too low to permit the study to be cost-effective. In addition, college students are probably not very representative of the general driving public. We sought to overcome these problems by using employees of a consulting firm who would drive enough miles each day to allow the study to be cost-effective

The authors thank Mark Moody and Richard Wolff for their helpful comments on an earlier version of the paper and Donna Merkal for serving as the reliability observer. Reprints may be obtained from R. M. Foxx, Department of Treatment Development, Anna Mental Health and Developmental Center, 1000 N. Main St., Anna, Illinois 62906.

and be more representative of the "real world."

More stringent subject selection criteria were used. In addition to the previous criteria that each subject have access to only one car and that only 5% of the driving of that car be done by someone else, we required that employees have both a considerable amount of driving (i.e., driving 40 or more miles per day) and a considerable amount of nonessential driving (i.e., 40% or more) that could be reduced without causing them hardship.

More stringent procedures for preventing and/or detecting rule violations were also incorporated. For example, we conducted 44 odometer checks (number of miles a person drives per unit of time as recorded by the car odometer) whereas Hake and Foxx (1978) conducted 17 checks. Increasing the number of checks was accomplished by eliminating the requirement that employees bring their cars to a checkpoint or indicate their cars' location on a map. Previously, subjects had been required to bring their cars by a checkpoint or participate in the map check because of the difficulty in locating their cars in the numerous university parking lots. Such checks were now unnecessary because all of the employees' cars were conveniently located in one of two parking lots. Also, eliminating the checkpoints would help make the study more economical because it allowed us to discontinue the attendance prizes that previously had been given to subjects who brought their cars to the odometer checkpoint.

Foxx and Hake (1977) and Hake and Foxx (1978) considered three factors in designing their programs to reduce driving. The first two, to define the driving response and to measure the driving response accurately, were retained. The third factor, using reinforcers of sufficient strength to counteract the intrinsic reinforcing properties of driving, was altered. Instead of providing individualized reinforcers, a lottery incentive system that included feedback was used because we believed that the $1 to $3 weekly prizes earned by college students would not motivate persons earning a sizable income (employees) to reduce their driving. Also, a lottery would help make the program more cost effective.

Lotteries have been used effectively in industry to reduce absenteeism and tardiness (Nord, 1969, 1970; Pedalino & Gamboa, 1974). The present lottery system required the employees to pay an entry fee in order to participate. This entry fee was used to simulate an office football or baseball pool and as a measure of the employees' motivation to participate. In addition, it served to make the study more cost-effective.

In summary, the present study sought to develop a driving reduction program that was both cost-effective and simple to implement in a business setting. The study differed from the previous research in that it featured: (a) a natural work setting, (b) more stringent subject selection criteria, (c) more stringent procedures for preventing and/or detecting rule violations, (d) the elimination of attendance prizes, and (e) a lottery combined with feedback to reduce the automobile driving of employed personnel.

METHOD

Participants

Employees of a research and development consulting firm were asked to volunteer for a study on car driving habits. The firm was located in a Washington, D.C. suburb because its business was based on securing contracts from the federal government. The company employed 220 persons, 85% of whom were professionals with college or advanced degrees and 15% of whom were clericals. The employees worked in one of two buildings that were located 2 mi. apart. Questionnaires were distributed to those in each building who volunteered. In one building, 67 of 150 persons who received questionnaires volunteered whereas 16 of 25 persons in the second building volunteered. Volunteers from the building with the most employees served as the experimental group while those from the other building served as the contrast group. We chose this method of group assignment in order to reduce the possibility that the

groups would learn of each other's existence. The questionnaire asked the volunteers: (a) to list all the cars they drove; (b) to estimate how many miles per month they drove each car; (c) to estimate the percentage of the driving for each car done by someone else; (d) to indicate if they ever carpooled to work; (e) to indicate if they were planning to take a vacation during the summer months (the period during which the study would be conducted); (f) to complete a series of questions that would enable us to compute their essential driving each week (e.g., the driving distance to work, distance and number of days driven to meet with clients); and (g) to sign their names if they were willing to participate. They were told that their participation was voluntary and that they could drop out any time. (A copy of the questionnaire can be obtained from the senior author.)

Criteria for participant selection. Participants were selected initially on the basis of their questionnaire responses. All met the following criteria: (a) 100% of their driving was done with one car; (b) less than 5% of the driving was done by another person; (c) they drove at least 40 mi. per day, (d) 40% or more of their driving was nonessential; and (e) they were not planning a vacation during the time of the study.

Final participant selection. The final participant selection was based on data collected during the 28-day initial baseline. Of the 67 employees who completed the questionnaire from the first building, 17 met the criteria and were initially selected. After the initial baseline, nine were dropped because they no longer met one or more of the criteria. Of the 16 employees who completed the questionnaire from the second building, six were initially selected. Because there were fewer employees and volunteers in the second building, the six were selected on the basis of the most important criteria and only the 40 mi. per day and the 40% nonessential driving criteria were waived for individuals although the group means met these criteria. Otherwise, there would not have been a sufficient number of participants to comprise the contrast group. Because contrast group employees were used to control for time-related variables (e.g., weather, holidays, increased fuel costs) and any possible effects of the participants "knowing" they were participating in a behavioral study on car driving habits, the above two driving criteria could be waived for individuals.

Experimental Design

The experimental design consisted of a baseline condition, in which no consequences were attached to driving behavior, and a lottery condition in which the experimental employees were rewarded for decreasing their average miles driven per day. The experimentals received an ABA order of conditions while the contrast group was in baseline throughout the study. This experimental design permitted both within-subjects (ABA reversal design) and limited between-groups comparisons.

Reliability of the response measure: the odometer reading. A car odometer provides a continuous and reliable measure of miles driven unless it is altered. Two procedures were used to detect alterations. First, the car's make, model, year, and license number was checked whenever the odometer was read to ensure that it was the correct car. Second, the frequent odometer checks allowed us to determine if the car's mileage had increased by a reasonable amount.

Artificial odometer manipulations were unlikely because: (a) it is difficult and illegal to disconnect the odometer cable and doing so also disconnects the speedometer, and (b) the employees did not know what we were observing during the initial baseline. In the initial baselines of the previous studies, subjects were aware that their odometers (or mileage) were being checked throughout the condition because they drove their cars to the odometer checkpoint. In the present study, however, the participants were unaware that their initial baseline mileage was being checked because they were present only during the first baseline day (described later). There was no need to have them present thereafter because we simply read the odometers

by looking through the cars' windows. Some employees, in fact, believed that we were only checking where their cars were being parked in the lot.

Ensuring that the employee was driving the designated car. To determine whether employees were using their designated cars and to help us find the car in a full parking lot, each person was required to place an orange, silver dollar-sized, cardboard circle inside the car's rear window so that it was visible from the outside. Employees were told that the orange circle was to aid the observers in recognizing the cars in the study. To reduce the possibility that designated cars were used only on a checkday, all checks for both groups were unannounced.

Another concern was that employees could have used another car over the weekends. Two factors argued against this. First, responses on the questionnaire indicated that the employees had access to only one car. Second, the amount of driving during the lottery and baseline conditions always exceeded the employee's total amount of essential driving related to work.

Recording days. Odometer checks were conducted between 9:30 a.m. and 11:00 a.m. at least three times per week for all conditions. A total of 44 checks were made: 16 and 13, respectively, during the two baselines and 15 during the lottery condition. Of the 660 total possible odometer checks (15 employees $\times$ 44 checks), cars were available and checked 505 times or 76.5%. When the car was not available, we called the employee to determine its location. When the employee was not available, a third party (usually a secretary or the company receptionist) was contacted to determine why the car was not in the parking lot. Cars were not available for four reasons: the employee had driven to a meeting, was sick, was out-of-town on business, or the car was being repaired.

One part-time employee, unaware of the design of the study, assisted in recording the odometer readings. Of the 44 checks, 17 or 39% were reliability checks. There were six reliability checks during the initial baseline, five during the lottery condition, and six during the final baseline. Reliability was calculated by dividing the number of agreements (where both observers recorded the same odometer reading) by the number of agreements plus disagreements times 100. Agreement between the recorders averaged 98.8%.

Procedure

Initial baseline. Participants were told that the driving study would not officially begin for another month. The first baseline day they were asked to place the orange circle inside their cars' windows. An experimenter accompanied them to their cars and recorded the car's make, model, year, and license number. In addition, the experimenter checked the odometer, the speedometer's range, and whether the car had a CB radio. These latter two checks were bogus. The employees were informed that someone would be occasionally checking their cars and if an employee's car was not in the parking lot, then the employee would be telephoned to determine the car's location. Neither the purpose of the car checks nor the intent of the study was explained. If employees asked questions, they were simply informed that their driving habits were being studied. The initial baseline lasted 28 days. Two experimental employees began one day late because they were absent on the first baseline day. One contrast group member was dropped because he resigned from the company. Two individuals who had been away on business during the initial questionnaire, but who met the criteria, were added to the contrast group after the second baseline week.

Lottery condition. On the final day of baseline, each experimental employee was given a "Personal Fuel Conservation Guide" that explained the contingencies. (A copy of the Personal Fuel Conservation Guide and rules of the study can be obtained from the senior author.) Mileage-reduction goals from 10 to 30% were stipulated that would qualify the employees for four weekly lotteries and one grand drawing at the end of the month. The mileage-reduction goals

were percent reductions in miles driven per day relative to the employee's initial baseline average. The dollar value of the lotteries was determined by the mileage reductions achieved. For a 10% reduction in average miles driven per day per week, an employee received one lottery ticket and $1 was added to the weekly pot; for a 20% reduction, three tickets were given and $2 was added to the weekly pot; and for a 30% reduction, six tickets were given and $3 was added to the weekly pot. The four weekly lotteries were held each Monday after the morning odometer checks.

The objective of the fixed-interval lottery schedules (i.e., one per week) was to increase the number of employees who had at least some mileage reduction by allowing the possibility of a weekly prize. The weekly fixed-interval schedules were interlocked (Hake & Foxx, 1978) to form a longer second-order schedule (cf. Kelleher, 1966) by requiring employees to meet the successive weekly contingencies (10% reduction or more) for one month to qualify for the grand drawing at the end of the month. The objective of the second-order schedule was to ensure a minimum 10% mileage reduction each week across the entire month-long experimental condition. This was preferable to just setting a target percent reduction goal for the entire month, e.g., 20%, that would qualify the employee for the grand drawing. Thus, the second-order schedule would ensure consistent weekly reductions for employees who were capable of large reductions but for whom the achievement of an average monthly reduction might be reached even with a weekly (short-term) mileage increase.

The value of the monthly lottery equaled the total of the four weekly lotteries. One ticket was given for a 10% reduction in average miles per day over the 28-day period; three tickets for a 20% reduction, and six tickets for a 30% reduction.

The guide listed the rules for the study. A $2 entry fee was required from each employee and his or her car had to be available for an odometer check every Monday. It was the employee's responsibility to inform us if she or he would be out of town that day so that alternate arrangements could be made for checking the odometer.

Part II of the guide contained a worksheet that indicated the employee's average miles driven per day during baseline and the miles per day that had to be averaged in order to achieve the 10 to 30% reductions. The worksheet contained 28 spaces where employees could calculate their miles driven per day. At the end of the experimental condition, the employees were asked to return the worksheets.

All employees were asked to read through their guides after which any questions were answered. It was emphasized that the purpose of the study was to motivate the employees to reduce or eliminate their unnecessary driving, but that they should not endure any hardships.

Every Monday the employees would gather in the second author's office for the weekly lottery. At this time, those who qualified for the weekly lottery were given tickets on which their mileage reductions were recorded. In addition, they were given feedback regarding their gasoline savings. Each ticket listed the dollar amount of gasoline savings achieved that week and projected for the year (i.e., 52 weeks) should the employee maintain that reduction. The amount of gasoline saved was based on the employee's estimated miles per gallon (mileage) for his or her car. Employees who increased their mileage during the week were given a card that showed how much this increase cost them in terms of additional dollars spent on gasoline that week and projected on an annual basis. One-half of the ticket was placed in a jar and the employee received the other half. Lottery winners were paid immediately after the drawing.

Feedback was also provided and summarized in the form of a 11″ × 14″ (28.2 cm × 35.8 cm) "Score Card" that was displayed in the experimenter's office. The card listed the employees, the mileage reduction each achieved, the number of tickets each collected, the dollar

amount each had earned for the lottery, the total value of that week's lottery, and the names of those who remained eligible for the monthly drawing. Also, the name of each weekly winner was prominently displayed.

On the day of the monthly drawing and after the winner was paid, the employees were told that the study had officially ended. However, they were told we would be occasionally checking their cars thereafter.

Final baseline condition. No contingencies were in effect during the return to baseline. For the contrast group, this final baseline was no different from the two previous conditions. The final baseline lasted 28 days for the majority of the employees. The baseline was extended to 31 days for one contrast group member in order to obtain a final odometer reading.

Final questionnaire and debriefing of participants. On the final day of the lottery condition, experimental employees were asked to complete a questionnaire that consisted of eight short answer questions concerning their driving during the study. All participants were debriefed after the last baseline check had been conducted.

RESULTS

Percent Reduction Relative to Baseline Conditions

Table 1 shows that during the lottery, the experimental group averaged driving 5.7 fewer mi. per day, which represented an 11.6% reduction from their initial baseline average. During the same period, the contrast group increased their average daily mileage by 8.2 mi. or a 21.2% increase from their initial baseline average. In the final baseline, both groups increased their average miles driven per day over their initial baseline: The experimental group increased by 4.3 mi. (8.8%) and the contrast group increased by 2.5 mi. (6.4%). The experimental group's reduction in absolute miles driven per day during the lottery was larger, 7.85 mi. (15.3% reduction), when both baselines were averaged whereas the contrast group's absolute increase in miles driven per day was smaller, 6.9 mi. (17% increase). Both these results were due to the small increase in driving that occurred during the second baseline.

Table 1 shows also that five of the eight experimental participants averaged at least some mileage reduction for the lottery condition while five of the seven contrast participants drove more per day. In the return to baseline, six of the eight experimentals increased their driving from the lottery condition thereby suggesting a possible contrast effect. Only two contrast group members showed an increase over this time. In comparing the average miles per day driven during the initial baseline versus final baseline, six of the eight experimentals increased while only three of the seven contrast participants increased.

Table 2 shows the effects of the weekly fixed-interval lottery contingencies (the four weekly lotteries). During the first lottery week, seven of the eight experimentals reduced their mileage; during the second week, three of eight reduced; during the third week, five of eight reduced; and during the fourth week, six of seven reduced. Of a total of 31 possible opportunities to reduce driving (the total number of participants over the 4-wk period), the experimentals reduced on 21 occasions or 67.7%. The contrast group members only reduced on 8 of 28 possible opportunities or 28.6%.

Six of the eight experimentals achieved at least a 10% reduction during one week and were eligible for a lottery drawing. The greatest group reductions occurred in the first and fourth weeks. During week one, seven experimentals reduced their mileage, but only four did so by 10% or more. The three who had reduced in week one but not enough to qualify for the lottery, increased their mileage in week two. Of the four qualifiers in week one, only Employee 7 increased during week two. She attributed this increase to a long-distance trip over the weekend related to a death in her family. Thereafter, she maintained sizable reductions during the remaining 2 wk. Although the experimentals achieved only a 2.4% reduction during week

Table 1

Employees' Miles Driven Per Day

Employee	Sex	Baseline I Days[a]	Baseline I Miles Driven/Day	Lottery Days	Lottery Miles Driven/Day	Lottery Percent Change	Baseline II Days	Baseline II Miles Driven/Day
				Experimental Group				
1	M	25	51.5	28	58.9	+14.4	28	43.3
2	M	23	44.5	18	25.6	−42.5	21	57.5
3	M	28	47.1	28	47.0	− 0.2	23.5	53.2
4	M	28	47.3	28	34.3	−27.5	25	58.2
5	M	28	51.1	26	55.0	+ 7.6	28	58.4
6	M	25	43.5	26	50.7	+16.6	20.5	46.9
7	F	27	56.9	28	47.0	−17.4	28	68.2
8	F	28	51.1	24	28.9	−43.4	26	41.6
Mean			49.1		43.4	−11.6		53.4
				Contrast Group				
1	F	28	15.0	28	14.2	− 5.3	28	13.2
2	F	14	37.6	28	53.7	+42.8	31	34.7
3	M	28	28.6	23.5	28.9	+ 1.0	28	43.0
4	F	28	47.1	28	43.0	− 8.7	28	44.3
5	F	20	16.4	28	23.6	+43.9	28	19.2
6	M	17	88.2	28	102.1	+15.8	28	87.1
7	M	17	42.1	28	66.9	+58.9	28	51.2
Mean			39.3		47.5	+21.2		41.8

[a]The number of days in each condition varied for some employees because days on which the car was not driven (e.g., business trips out of town, car in repair shop) were subtracted from the total. Half days were used when the employee only drove to or from work on that particular day (e.g., when an employee drove to work but went out of town on business and did not return until the next day). Days on which the individual called in sick were not subtracted because the individual still had access to the car.

three, the contrasts increased their mileage by 42.3%, their greatest increase for any week. The apparent cause was that the Mother's Day weekend fell during week three, since both groups showed a large increase in mileage over this weekend. During week four, six of seven experimentals achieved a reduction (one employee was out of town the entire week) and five achieved at least a 10% reduction.

The Lottery Winners

Table 2 shows that the first weekly lottery of $10 was won by Employee 7, the week's third largest reducer. In week two, Employee 4, the second largest reducer, won the $9 pot. The $10 third week pot was won by Employee 2, the second largest reducer. The fourth weekly lottery of $12 was won by Employee 4, the third largest reducer. Employee 4 was the only participant who won two weekly lotteries.

Only Employees 4 and 8 maintained a consistent reduction of over 10% each week and averaged 28 and 43%, respectively. Employee 2 maintained a reduction of greater than 10% over the first 3 wk but was not eligible for the monthly drawing because he had to make an unscheduled out-of-town trip during week four. The winner of the $41 grand drawing (Employee 8) had maintained the largest reduction over the 4-wk period (see Table 1).

Essential Driving

One goal of the study was to reduce the number of nonessential miles driven. Nonessential miles were considered to be any mileage that was not related to driving to work or to meet

Table 2
Employees' Miles Driven Per Week

Employee	Baseline I Miles/Days	Lottery Week 1 Miles/ Day	Lottery Week 1 Percent Change	Lottery Week 2 Miles/ Day	Lottery Week 2 Percent Change	Lottery Week 3 Miles/ Day	Lottery Week 3 Percent Change	Lottery Week 4 Miles/ Day	Lottery Week 4 Percent Change
Experimental Group									
1	51.5	65.6	+27	61.6	+20	77.9	+51	30.7	−40
2	44.5	21.2	−52	28.1	−37	28.5	−36[a]	—	—
3	47.1	44.6	− 5	52.6	+12	42.9	− 9	47.9	+ 2
4	47.3	36.6	−23	30.9	−35[a]	36.8	−22	32.7	−31[a]
5	51.1	47.7	− 7	59.4	+16	73.1	+43	41.3	−19
6	43.5	41.4	− 5	55.8	+28	59.8	+37	43.0	− 1
7	56.9	40.8	−28[a]	67.8	+19	42.3	−26	36.9	−35
8[b]	51.1	25.8	−50	34.8	−32	21.8	−57	36.6	−28
Mean	49.1	40.5	−17.9	48.9	− 1.1	47.9	− 2.4	38.4	−21.7
Contrast Group									
1	15.0	15.2	+ 1	15.6	+ 4	13.4	−11	12.4	−17
2	37.6	17.6	−53	40.0	+ 6	96.0	+155	61.1	+63
3	28.6	27.7	− 3	35.1	+23	29.3	+ 2	24.7	−14
4	47.1	48.7	+ 3	43.1	− 8	45.1	− 4	35.2	−25
5	16.4	23.3	+42	23.8	+45	23.0	+40	24.4	+49
6	88.2	89.8	+ 2	98.5	+12	122.7	+39	102.8	+17
7	42.1	45.2	+ 7	73.5	+75	73.5	+75	75.4	+79
Mean	39.3	38.2	− 0.1	47.1	+22.4	57.6	+42.3	48.0	+21.7

[a]Weekly lottery winners
[b]Grand prize winner

clients. Conversely, essential mileage was any driving that was related to these activities. The employees' weekly essential mileage was determined by the prebaseline questionnaire but also was monitored throughout the study. An employee's percentage of essential mileage was computed as the mileage associated with work divided by total miles driven during a condition, times 100. The experimentals' essential driving increased from 39.9% in the initial baseline to 46.9% in the lottery condition thereby indicating that their nonessential driving had been reduced. Their percentage of essential driving decreased to 33.5% in the final baseline. The contrast group's percentage of essential driving was 45.3% in the initial baseline, 39.4% in the lottery condition, and 41.3% in the final baseline. Percentage of essential driving served as a check that it was the lottery contingencies that controlled the experimentals' driving behavior and as a measure of reliability in that the total number of miles driven during each condition was always greater than the total essential miles driven. Switching cars would have been indicated if the employees' actual odometer mileage had been less than the total essential miles connected with work-related driving.

Cost-Benefit Analysis

Although the study's first goal was to determine whether a lottery could be used to reduce the number of nonessential miles driven, the second goal was to design a program that was cost-effective. In the Hake and Foxx (1978) study, the monetary prizes had been too large to make the study cost-effective because the prizes cost $126 whereas the subjects saved only $80 on gasoline.

The present study almost proved to be cost-effective based on the price of gasoline during

the study. Factors contributing to the cost-effectiveness included the deletion of the attendance prizes used in the previous studies, the use of drivers who could produce meaningful reductions (i.e., those who drove 40 or more miles per day) and the use of a lottery contingency.

To determine the actual amount of gasoline saved, the absolute reduction in miles driven per day for each employee was calculated relative to the employee's average of both the initial and final baselines in order to counterbalance for any time-correlated changes in the amount of driving. This absolute miles per day figure was then divided by the estimated miles per gallon (mpg) for the employee's car in order to determine the number of gallons of gasoline saved or used per day. The estimated mpg was either derived from the Environmental Protection Agency's figures on city driving for the employees' cars or the employees' figures if they

Table 3

Cost Benefit Analysis

Employee	*Miles Driven/ Day (average both baselines)*	*Miles Driven/ Day in Lottery Condition*	*Change in Miles Driven/ Day Lottery Condition*	*EST mpg*	*Change in # of Gallons (daily gallons saved × the number of lottery days)*	*Gasoline Savings in dollars (# Gallons × $0.70/Gallon)*
				Lottery Group		
1	47.4	58.9	+11.5	20	.575 × 28 = +16.10 Gals.	+11.27
2	51.0	25.6	−25.4	8	3.175 × 18 = −57.15 Gals.	−40.00
3	50.1	47.0	− 3.1	19	.163 × 28 = − 4.56 Gals.	− 3.19
4	52.7	34.3	−18.4	21	.876 × 28 = −24.53 Gals.	−17.17
5	54.75	55.0	+ .3	18	.016 × 26 = + .42 Gals.	+ 0.29
6	45.2	50.7	+ 5.5	15	.366 × 26 = + 9.52 Gals.	+ 6.66
7	62.6	47.0	−15.6	19	.821 × 28 = −22.99 Gals.	−16.09
8	46.3	28.9	−17.4	17	1.024 × 24 = −24.58 Gals.	−17.21
				Total	−107.77 Gals.	$−75.44
				Contrast Group		
1	14.1	14.2	+ .1	12	.008 × 28 = + .22 Gals.	+ .15
2	36.1	53.7	+17.6	18	.978 × 28 = +27.38 Gals.	+19.17
3	35.8	28.9	− 6.9	18	.383 × 23.5 = − 9.00 Gals.	− 6.30
4	45.7	43.0	− 2.7	13	.208 × 28 = − 5.82 Gals.	− 4.07
5	17.8	23.6	+ 5.8	19	.305 × 28 = + 8.54 Gals.	+ 5.98
6	87.6	102.1	+14.5	24	.604 × 28 = +16.91 Gals.	+11.84
7	46.6	66.9	+20.3	16	1.27 × 28 = +35.56 Gals.	+24.89
				Total	+73.79 Gals.	$+51.66

Cost Benefit Analysis Lottery Group[a]

	Savings		*Expenses*	
$13.25 Personnel costs[1]			Labor and Materials	$13.65
.40 Materials[2]			Lottery Prizes ($82 less $16 in entry fees)	66.00
$13.65 Total	Total Gasoline Savings	$75.44	Total Cost	$79.65

[1]($2.65 hourly minimum wage × 5.5 hours): 1½ hour for odometer checks (includes reliability observer); 1 hour conducting lotteries; ½ hour explaining program; 1 hour calculating reductions, preparing lottery tickets, and updating score card; 1 hour typing guides and recording forms and duplication.

[2](score card, $.07; parking decals, $.10; lottery tickets, $.02; paper, $.21).

[a]With the exception of ½ hour to explain the program, personnel costs were based solely on time spent during the lottery condition that was related to the experimental participants.

had calculated their mpg in the recent past. The daily number of gallons of gasoline saved or used was then multiplied by the number of days the employee was in the lottery condition to obtain the number of gallons used or saved during the lottery condition.

Table 3 shows that the experimental group saved 107.8 gallons of gasoline in the lottery condition whereas the contrast group used an additional 73.8 gallons. Gallons saved or used was translated into a dollar amount by multiplying the number of gallons saved, or used, by $.70 per gallon of gas (estimated current gas price). The experimental group's total savings during the lottery condition was $75.44 while the contrast group's total extra expenditure for gas during this period was $51.66.

Table 3 shows that the total cost of this study was $79.65 and the total experimental group savings was $75.44. Thus, the present effort came within $4.21 of being cost-effective.

Questionnaire Responses

On the final day of the lottery condition, the experimentals completed a questionnaire that asked them: (a) their strategies for reducing driving, (b) their reasons for reducing mileage, (c) why they did not achieve larger reductions, (d) whether they had tried to reduce their mileage, (e) whether they had tried to circumvent the rules, (f) whether they had knowledge of the other group, and (g) their suggestions for motivating persons to reduce their mileage.

Several strategies were reported for reducing driving: combining several errands into one trip, using the shortest route to a destination, and reducing the number of unnecessary trips. The four largest reducers (Employees 2, 4, 7, and 8) stated that they did not volunteer to drive when making travel plans with a group. Reasons for reducing mileage included the cash involved (Employees 1, 2, 7, and 8), the challenge and interest in trying to "analyze my driving habits for the first time" (Employees 3, 4, and 8), the competition, and the recognition of being listed as winner on the "Score Card" (Employees 7 and 8). Several reasons were given for why larger reductions were not achieved. Employee 1, whose mileage increased the greatest, indicated that his driving requirements were irregular and that he had to meet with clients more frequently during the lottery condition than during either baseline. In addition, the lottery condition coincided with his turn to visit his girlfriend who lived approximately 200 miles away whereas during the baselines, it had been her turn to drive to visit him. Employee 4 stated that larger reductions were impossible because erratic client demands required him to make a number of unscheduled local trips. Employee 5 indicated that he had bought a house in the country during the study and as a result was making a greater number of long-distance trips. All employees, except Employee 5, who had a 7.6% increase, indicated that they tried to reduce their mileage during the lottery condition. No one reported trying to circumvent the study's rules and only Employees 4 and 8 reported being aware that another group was participating. However, neither could state which employees comprised the contrast group or how that group fit into the experimental design. A number of suggestions were provided for motivating employees to reduce their driving: (a) allow group discussion after the lotteries are held so that different strategies for reducing mileage can be shared, (b) provide more money in the lottery, and (c) require self-recording.

On the final day of the lottery condition, the contrast group members were asked whether they were aware of the other group and the lottery contingencies. None was.

DISCUSSION

The present results replicated and extended the previous research on gasoline conservation. The experimentals' average miles reduced per day per employee was 7.85 whereas Foxx and Hake's subjects reduced by 7.65 mi. and Hake and Foxx's subjects reduced by 7.93 mi. Furthermore, the present percent mileage reduction,

15.3% (percent reduction in miles driven per day relative to the averaged baselines), was comparable to those obtained in the previous two studies: Foxx and Hake (1977) obtained a 21.7% reduction and Hake and Foxx (1978) a 19.7% reduction. The more meaningful and applied of the two variables, however, is absolute miles reduced per day because it translates directly into gasoline and money saved whereas percent reduction does not.

There were two limitations of the experimental design that must be addressed because they influence how the results are interpreted. The first was that it is impossible to say exactly what caused the experimentals' driving reductions because several factors were operating during the lottery condition besides the simple lottery contingency. These factors included the public posting of reductions and increases, that some employees did self-record on occasion, feedback, and the setting of criteria regarding the desired amounts of mileage reductions. The second limitation is the apparent nonequivalence of the two groups in that two subject-selection criteria, 40+ miles driven per day, and 40% nonessential mileage, were waived for individual contrast group members. The waiving of these two criteria appears to preclude any comparisons of the two groups or suggests that any comparisons are, at best, tenuous. However, several factors argue in favor of making at least some limited between-groups comparisons. First, the contrast group's means met both criteria. Second, five of the seven contrast employees did have over 40% nonessential mileage and the two who did not (Employees 4 and 5) had 31% nonessential mileage and one increased her mileage during the lottery condition whereas the other decreased. Third, two of the three contrast group members who had an initial baseline average of over 40 miles per day increased their driving during the lottery condition. And, a fourth employee (Employee 2) who had an initial baseline average of 37.6 miles per day also increased her driving during the lottery. Thus, the results for the contrast employees who were comparable to experimental employees on the two criteria do support the contention that the independent variables had an effect on some of the experimentals as, of course, do the within-subjects comparisons. The bottom line is that fuel conservation is an area in which it is very difficult to establish all of the necessary controls.

In contrast to the previous studies, the present study came very close to being cost-effective in that the dollar amount of gasoline conserved was within $1.09 of the cost of motivating the employees to reduce their driving. The reasons have been mentioned previously: eliminating the attendance prizes, dispensing with individual monetary prizes, using subject-selection criteria that permit the achievement of sizable, cost-effective reductions in average miles per day, and requiring an entry fee to help defray the program's costs.

The present study improved and simplified the methodology used in the previous two studies. Our increased number of odometer checks—44 vs. 17 in the Hake and Foxx (1978) study—provided more information about the employees' driving behavior and increased the likelihood that any "cheaters" would be detected. For example, the four checks per lottery week allowed us to ascertain that the largest increases in nonessential driving were occurring during weekends. There was also a significant savings in experimenter time. In the previous studies, odometer checks were conducted between 1:00 and 6:00 p.m. so that the subjects could drive by the checkpoint as they were leaving campus. In the present study, all odometer checks were conducted easily in about 20 min because the cars were located in one parking lot. In future studies in business-type settings, these odometer checks could be accomplished easily by someone, such as a company security guard, who could either check the cars while they were in a lot or check them as the drivers entered or left the parking lot.

There are several ways to enhance the effectiveness of future lottery programs and realize greater gasoline savings:

1. Select employees from a stable work environment, e.g., factories, institutions, governmental agencies, in short, where employees maintain a routine "9 to 5" work schedule. In the present study, the participating employees did not appear to be representative of typical employed personnel because their work day was irregular, i.e., they made frequent unscheduled trips in response to client demands. These clients' demands not only prevented the participants from combining a number of meetings into one trip in order to save fuel but actually caused them to use more gasoline as seven of the eight subjects indicated on their questionnaires.

2. Reduce the minimum mileage reduction required to be eligible for the weekly and monthly drawings. In the present study, seven of the eight participants reduced their driving in the first lottery week, yet three were ineligible for the lottery because their reductions were less than 10%. All three increased their driving over baseline in the second lottery week and two increased during the third week. It is conceivable that the three participants' failure to qualify the first week after they had achieved some reduction may have dampened their enthusiasm in regards to the achievement of subsequent reductions. A possible solution to this problem would be to provide one ticket for any weekly reductions (absolute or percentage) or perhaps for a minimum reduction of 5%.

3. Provide feedback as to what percentage of the employee's driving is nonessential vs. essential since the purpose of a gasoline conservation program is to reduce nonessential driving.

4. Provide feedback daily or several times a week to the employees on miles driven thus far that week, miles averaged per day, how this average compared with their baseline mileage per day, and the number of miles that had to be reduced from that point in order to achieve the prespecified mileage reduction goals for that week. A similar form of feedback has proved successful in reducing the daily electricity consumption of residential consumers (Hayes & Cone, 1977; Palmer, Lloyd, & Lloyd, 1977).

5. Require the participants to self-record. Foxx and Hake (1977) found that subjects who self-recorded achieved the largest mileage reductions and Hake and Foxx (1978) found that subjects reinforced solely for self-recording mileage reduced their average miles driven per pay by 12%. None of the participants in the present study consistently recorded mileage, although the greatest reducers (Employees 4 and 8) did calculate the maximum weekly mileage they could not exceed in order to achieve a 10% reduction and always knew their percent reduction before it was calculated by the experimenter.

6. Choose absolute miles reduced as a dependent variable rather than percent reduction for the reasons discussed previously.

Although the present study concentrated on the personal driving of employees, the next logical step would be to involve companies or organizations that were interested in conserving the fuel used for their fleet vehicles. Any mileage reductions achieved would be reflected in an immediate savings of the organization's gasoline costs. Such a preliminary attempt had been made by Lauridsen (Note 1) and Runnion, Watson, and McWhorter (1978). In both studies, lotteries and feedback were used to motivate company drivers to increase miles per gallon.

If companies or organizations were to implement the lottery system, they could substitute for or combine naturally occurring work setting reinforcers with monetary reinforcers. The natural reinforcers could include time off, flexible working hours, preferential personal parking privileges, or paid vacations. The duration of these privileges could be scaled according to the size or duration of the mileage reductions. Or, competition between departments (in the fashion of the United Fund drive) could be substituted for the lottery system. Finally, employee recognition programs where the names of big mileage reducers were printed in the company newspaper or magazine could be used as a source of social reinforcement and feedback.

In conclusion, the present study came very

close to accomplishing its two major goals: A nearly cost-effective fuel conservation program was developed and it was applied to a realistic, applied setting. The development of a comprehensive fuel conservation program is an evolutionary process that is presently in the "Ice Age" state of development. The continued involvement of applied behavior analysis in trying to solve the energy crisis will in some way, we hope, keep this figurative suggestion from becoming a literal statement of the world's condition.

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Received March 13, 1979
Final acceptance January 28, 1981